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(54) Lens plasma coating system

(57) A system and method for treating the surface of an optical lens is provided. A predetermined pressure and a plasma gas are maintained in a coating chamber. A plasma cloud of gas is established between electrodes in the chamber. An entry chamber is upstream from the coating chamber, and an exit chamber is disposed downstream from the chamber. A lens is moved into the entry chamber, and at least a portion of the entry chamber adjacent to the coating chamber is brought to the predetermined pressure. Process gas is introduced into this area. The entry chamber is then brought into communication with the coating chamber, and the lens is moved into the coating chamber and through the cloud. Process gas is introduced into at least a portion of the exit chamber adjacent the coating chamber, and this portion is brought to the predetermined pressure. The lens is then moved from the coating chamber to the exit chamber.

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chamber communicates with the exit chamber through the second exit gate and the third entrance gate so that the coating chamber conveyor and the exit chamber conveyor communicate to pass the lens from the coating chamber to the exit chamber.

[0009] The present invention thus in one aspect relates to a system for treating the surface of an optical lens, said system comprising:

an entry chamber having a first entrance gate and a first exit gate, said first entrance gate and said first exit gate sealing said entry chamber when closed, and said entry chamber including a conveyor extending between said first entrance gate and said first exit gate;
a first negative pressure source in selective communication with said entry chamber;
a coating chamber having a second entrance gate and a second exit gate, said second entrance gate and said second exit gate sealing said coating chamber when closed, and
said coating chamber including at least a pair of spaced apart electrodes disposed therein and a conveyor extending between said second entrance gate and said second exit gate so that said conveyor conveys said lens between said electrodes;
a source of plasma gas in communication with said coating chamber to introduce said gas into said coating chamber;
a second negative pressure source in communication with said coating chamber;
an electrical power source in communication with said electrodes to apply a predetermined electrical potential at each said electrode so that, upon establishment of a predetermined pressure in said coating chamber by said second negative pressure source, a plasma cloud of said gas is established between said electrodes;
an exit chamber having a third entrance gate and a third exit gate, said third entrance gate and said third exit gate sealing said exit chamber when closed and said exit chamber including a conveyor extending between said third entrance gate and said third exit gate; and
a third negative pressure source in selective communication with said exit chamber,
wherein said entry chamber communicates with said coating chamber through said first exit gate and said second entrance gate so that said entry chamber conveyor and said coating chamber conveyor communicate to pass said lens from said entry chamber to said coating chamber, and
wherein said coating chamber communicates with said exit chamber through said second exit gate and said third entrance gate so that said coating chamber conveyor and said exit chamber conveyor communicate to pass said lens from said coating chamber to said exit chamber.

[0010] A method for treating the surface of an optical lens according to the present invention includes providing first an optical lens and providing a coating chamber including a pair of spaced apart electrodes disposed therein. A plasma gas is maintained in the coating chamber. A first predetermined pressure is maintained in the coating chamber, and a predetermined electric potential is maintained at each electrode so that a plasma cloud of gas is established between the electrodes. An entry chamber is provided upstream from the coating chamber, and the first lens is moved into the entry chamber. Gas is introduced into at least a portion of the entry chamber adjacent the coating chamber, and at least that portion of the entry chamber is brought to the first predetermined pressure. The entry chamber is brought into communication with the coating chamber, and the first lens is moved from the entry chamber into the coating chamber and through the plasma cloud. An exit chamber is provided downstream from the coating chamber. Gas is introduced into at least a portion of the exit chamber adjacent the coating chamber, and at least that portion of the exit chamber is brought to the first predetermined pressure. The first lens is moved from the coating chamber to the exit chamber.

[0011] The present invention thus in a further aspect relates to A method for treating the surface of an optical lens, said method comprising the steps of:

(A) providing said optical lens;
(B) providing a coating chamber including a pair of spaced apart electrodes disposed therein;
(C) maintaining a plasma gas in said coating chamber;
(D) maintaining a first predetermined pressure in said coating chamber and a predetermined electric potential at each said electrode so that a plasma cloud of said gas is established between said electrodes;
(E) providing an entry chamber upstream from said coating chamber;
(F) moving said first lens into said entry chamber;
(G) introducing said gas into at least a portion of said entry chamber adjacent said coating chamber and bringing said at least a portion of said entry chamber to said first predetermined pressure;
(H) bringing said entry chamber into communication with said coating chamber;
(I) moving said first lens from said entry chamber into said coating chamber and through said cloud;
(J) providing an exit chamber downstream from said coating chamber;
(K) introducing said gas into at least a portion of said exit chamber adjacent said coating chamber and bringing said at least a portion of said exit chamber to said first predetermined pressure; and
(L) moving said first lens from said coating chamber to said exit chamber.

signed U.S. Patent No. 5,874,127, to Winterton and Grant.

[0019] Referring again to Figure 1A, and also referring to Figure 2, each holding tray 10 includes a pair of hooks 32 on the opposing outer vertical members 14 of frame 12. Corresponding hooks 34 on a tray carrier 36 receive hooks 32 so that holding tray 10 may be hung on the tray carrier. In the embodiment shown in Figure 2, carrier 36 may hold four holding trays 10 and, therefore, up to three hundred ninety two lens cores.

[0020] Referring now to Figures 3A and 3B, the tray carrier is placed into a linear plasma coating system 40. Initially, the trays move through a drying chamber comprised of five subchambers (hereinafter referred to as "zones") 42A - 42E, each approximately five meters long. The tray carrier remains for a total of about twenty minutes in the drying chamber for a desired time, say about twenty minutes or sufficient to meet the necessary vacuum and coating application target.

[0021] Because the lens cores may contain a hydrophilic material, they can be hygroscopic and therefore can absorb water from the environment. Thus, it may be desirable to allow drying time. The dry zones maintain a constant relative humidity level, e.g., at or below ten percent to permit further drying, if necessary, and also provide a dry buffer area in which to place lens cores prior to entering the coating zones.

[0022] Referring also to Figures 2, 4A and 4B, each tray carrier is received in a rectangular slot 44 defined as a "slug" 46. A pair of bolts secures the carrier in the slug. A bore 48 extends through slug 46 beneath the tray carrier. The drying chamber includes a conveyor to transport the slug and carrier (hereinafter referred to collectively as the "carrier" unless otherwise indicated). The conveyor is comprised of individual conveyors in the zones 42A - 42E, each extending between opposing wheels 52 and 54. A servo motor 56 drives the conveyor and may be controlled by a personal computer, main frame system or other programmable logic circuit (hereinafter referred to generally as "PLC"). Two side members 58 sit on respective sides of the conveyor, and rollers 60 are disposed in gaps 62 in each side member to guide the tray carrier as it passes between the side members.

[0023] A light source 64 mounted in one side member directs light across to the other side member, where it is detected by a light detector 66. The light source and light detector are aligned so that light passes between them through bore 48 in slug 46. Light detector 66 outputs a signal to the PLC which, in turn, controls servo motor 56. Accordingly, the PLC detects the carrier's presence as the slug initially breaks the light beam between source 64 and detector 66 upon entering the first dry zone 42A. Other carrier detection systems may be utilized in lieu of the light detector; for example pressure or contact microswitches may also be employed. When bore 48 reaches the light source/detector pair, detector 66 again detects the light beam, and the PLC stops servo motor 56 for an approximate preprogrammed time say four minutes. At the end of this time, the PLC again activates motor 56 so that the carrier is passed to the second dry zone, 42B. Dry zone 42B has a conveyor, motor and side member pair like that of zone 42A, except that an additional mechanism is included in zone 42B to rotate the side members and conveyor ninety degrees so that the carrier may be passed to zone 42C. In each zone, however, a light source/detector pair is provided to detect the presence of a carrier in the zone. The PLC moves the carrier from one dry zone to the next if no carrier is still waiting in the subsequent zone.

[0024] The entrance to zone 42A may be open or may have a suitable covering as appropriate for a given system. A respective duct 68 feeds from a suitable air handling system (not shown) and directs the conditioned air or gas to each dry zone. Suitable ventilation ducts may also be provided. The air conditioning system may be independently controlled to continuously provide properly temperature-controlled and humidified air to the ducts, e.g., at approximately 70°F +/-2°.

[0025] Referring again to Figures 3A and 3B, the PLC moves the carrier through a slit valve 72 into an entry lock 70 if the carrier has been in dry zone 42E for a sufficient duration, if no carrier is waiting in entry lock 70, and if suitable conditions exist in entry lock 70 as described in more detail below. Entry lock 70 includes a conveyor 50 and side members 58 as in the dry zones. A light source/detector pair is also provided so that the PLC senses when the carrier is fully within the entry lock. The PLC then stops the servo motor that drives the conveyor and closes the slit valves at the entry lock's entrance and exit to seal the entry lock.

[0026] Referring also to Figures 5A and 5B, the entrance slit valve 72 includes a door 74 having a sealing material 76 that lines the periphery of its inside surface. Door 74 is hinged so that it is movable by a linkage 78 between an open and closed position. The PLC controls linkage 78. When the door is in its closed position, seal 76 surrounds and seals an entrance passage 80 into entry lock 70.

[0027] When the light source/detector in entry lock 70 detects the presence of the carrier through bore 48 (Figure 2), the PLC closes the slit valves at both ends of entry lock 70. The entry lock is a stainless steel chamber with which inlets, outlets and sensors may communicate as discussed below. It is a closed chamber except for the slit valves. Thus, when the valves are closed, the entry lock is sealed.

[0028] When the carrier is in the entry lock, and the chamber is sealed, the PLC activates a valve 82 and a pump 84 to pump out the entry lock and thereby create a vacuum condition therein. Specifically, the pump brings the interior area of entry lock 70 from ambient pressure to a desired preset lower pressure, e.g., at or below one mTorr. The PLC monitors the entry lock's pressure by a pressure sensor 85 extending through the entry lock's housing.

essary, the PLC can vent the coating zones with dry gas through valves 144 and 146. The PLC monitors pressure in the coating zones through pressure sensors 148/149 and 150/151.

[0039] An exit buffer 152 follows the second coating zone 128. As with the entry buffer and the coating zones, it includes a conveyor and servo motor that may be operated by the PLC. It also includes vertical members 58 and a light source and detector pair. The PLC maintains the process pressure level in the exit buffer through a valve 154 opening to a vacuum pump 156. The PLC monitors pressure in the exit buffer through a pressure sensor 158 and controls the flow of process gas from line 110 into the exit buffer from a mass flow controller 160 by a valve 162.

[0040] There are no slit valves between entry buffer 112 and first coating zone 126, between first coating zone 126 and second coating zone 128, or between second coating zone 128 and exit buffer 152. Instead, several steel shoulders 164 extend partially laterally into the system to create a channel extending from the entry buffer through the two coating zones to the exit buffer. Thus, the entry buffer chamber, coating zones and exit buffer chamber define a segmented common chamber. As noted above, the PLC maintains this common chamber at the process pressure, and maintains process gas in the chamber, during the system's operation through respective valves and mass flow controllers. Because of the selective pressurization and depressurization of the entry hold discussed above, and of the exit hold discussed below, the system may coat lens cores on successive tray carriers without having to pressurize and depressurize the coating zones.

[0041] The illustrated coating zones 126 and 128 are identically constructed. For ease of explanation, therefore, only the structure of coating zone 126 is described herein.

[0042] Coating zone 126 includes two tandemly arranged magnetrons, each having a pair of opposing electrodes 166 and 168. The use of a magnetron is optional, depending on the application. Referring to the schematic cross-sectional view in Figure 6A, the coating zone does not include vertical members 58 (Figures 4A - 4B) that would otherwise interfere with the application of the plasma cloud to the lens cores. The cloud is created by electrodes 166 and 168, which include rectangular titanium plates 170 and 172. Each titanium plate is separated from a respective magnetic device 174 and 176 by four 2 mm - 3 mm ceramic buttons 178. Each titanium plate is approximately 50 centimeters high, 1/16 inches (0.16 centimeters) thick and 18 centimeters long.

[0043] Each magnetic device 174 and 176 may include an outer metal box, for example made of stainless steel, through which cooling water may be pumped from tubes 180. Referring also to Figure 6B, the interior of each box includes a rectangular central steel core 182 and a surrounding rectangular steel ring 184. A series of permanent magnets 186 extend between core 182 and ring 184 and are arranged in a north-south pattern as shown in Figure 6B so that central core 182 is a magnetic "south" pole and outer ring 184 is a magnetic "north" pole. Although the exact opposite can also be employed, i.e., the north/south magnets may be totally reversed. Each permanent magnet is separated from adjacent parallel magnets by an approximately two inch (5.1 centimeters) gap. Titanium plates 170 and 172 are driven to the same electric potential by an AC power source 188 through a transformer 194. The strength of the magnets may be varied to control the extent of the plasma by one skilled in the art.

[0044] A distance of approximately seven to ten centimeters separates titanium plates 172 and 178. When energized, the plates create a plasma cloud between them as should be understood in the art. The 2 mm - 3 mm gap between the titanium plates and their respective magnetic devices is so small, however, that no sufficient plasma occurs there. The magnetic field created by the magnetic devices behind the titanium plates also prevents plasma formation. This creates a predictable, stable and relatively uniform plasma cloud between the plates. While an intensely glowing rectangular plasma area 188 is created immediately in front of each of the titanium plates, a plasma cloud 190 between areas 188 has less plasma definition but more uniformity. Specifically, it is more uniform in the vertical direction. Cloud 190 sits above conveyor 50, and it is therefore through this cloud that the lens cores are moved.

[0045] Referring again to Figures 3A and 3B, each electrode pair 166/168 includes its own pressure sensor 148/149 and vacuum throttle valve 130. As noted above, each electrode pair may also include its own process gas throttle valve. The PLC constantly monitors the pressure in the area in which each electrode pair is disposed and adjusts valves 130 and 136 accordingly to maintain the processing pressure condition. That is, in one embodiment, the process gas flow rate into the area is constant. Throttle valves 130, however, are set to the processing pressure and, therefore, control the out flow rate to maintain the desired pressure. Thus, the uniform plasma clouds remain consistent from one electrode pair to the next. Further, the process gas inlet from each valve 136 is placed behind one of the electrodes 166 or 168 so that the flow from the process gas line is blocked by the electrodes and does not disturb the plasma cloud. Other gas diversion schemes may be designed that accomplish the same end, but using the electrode pair is a convenient solution.

[0046] In one embodiment of the present invention, the process gas is seventy percent methane and thirty percent air (a dry mixture of nitrogen and oxygen). It was been found that including oxygen in the process gas provides highly useful means for maintaining the reaction (plasma) chamber clear of deposits such that the coating zone does not have to be cleaned routinely. As can be appreciated, in a continuous plasma apparatus, it is

wherein said entry chamber communicates with said coating chamber through said first exit gate and said second entrance gate so that said entry chamber conveyor and said coating chamber conveyor communicate to pass said lens from said entry chamber to said coating chamber, and
wherein said coating chamber communicates with said exit chamber through said second exit gate and said third entrance gate so that said coating chamber conveyor and said exit chamber conveyor communicate to pass said lens from said coating chamber to said exit chamber.

2. The system as in claim 1, wherein said gas is a plasma polymerizable gas.

3. The system as in claim 1, wherein said entry chamber includes

an entry lock chamber,
an entry hold chamber upstream from said entry lock chamber and in communication with said coating chamber by said first exit gate and said second entrance gate, and
a gate disposed between said entry hold chamber and said entry lock chamber so that said entry lock chamber and said entry hold chamber are sealed from each other when said gate therebetween is closed,
said first negative pressure source is in selective communication with each of said entry lock chamber and said entry hold chamber, and
said system includes a source of plasma gas in communication with said entry hold chamber to introduce said gas into said entry hold chamber.

4. The system as in claim 3, including a vent source in communication with said entry lock chamber to introduce a vent gas therein.

5. The system as in claim 3, including a vent source in communication with said entry hold chamber to introduce a vent gas therein.

6. The system as in claim 1, wherein

said exit chamber includes
an exit hold chamber in communication with said coating chamber by said second exit gate and said third entrance gate,
an exit lock chamber downstream from said exit hold chamber, and
a gate disposed between said exit lock chamber and said exit hold chamber so that said exit hold chamber and said exit lock chamber are sealed from each other when said gate therebetween is closed,
said third negative pressure source is in selective communication with each of said exit lock chamber and said exit hold chamber, and
said system includes a source of plasma gas in communication with said exit hold chamber to introduce said gas into said exit hold chamber.

7. The system as in claim 6, including a vent source in communication with said exit lock chamber to introduce a vent gas therein.

8. The system as in claim 6, including a vent source in communication with said exit hold chamber to introduce a vent gas therein.

9. The system as in claim 1, including

a drying chamber upstream from said entry chamber and in communication with said entry chamber by said first entrance gate, said drying chamber including a conveyor extending between an entrance to said drying chamber and said first entrance gate, and
a gas source in communication with said drying chamber so that said gas source provides a gas having a predetermined relative humidity to an interior area of said drying chamber.

10. The system as in claim 9, wherein said drying chamber includes a series of tandemly arranged subchambers.

11. The system as in claim 1, including a control system in operative communication with said entry chamber conveyor, said coating chamber conveyor, said exit chamber conveyor, said first negative pressure source, said second negative pressure source, said third negative pressure source, said gas source, said first exit gate, said second entrance gate, said second exit gate and said third entrance gate, said control system configured to activate said second negative pressure source to maintain said predetermined pressure in said coating chamber,

activate said gas source to maintain said gas in said coating chamber,
activate said entry chamber conveyor to move said lens into said entry chamber when said entry chamber is at ambient pressure and said first exit gate is closed,
thereafter, when said first entrance gate is closed, activate said first negative pressure source to bring an area within said entry chamber adjacent said first exit gate to said predetermined pressure,
thereafter open said first exit gate and said second entrance gate and activate said entry chamber conveyor and said coating chamber conveyor to move said lens from said entry

activate said second gas source to maintain said gas in said coating chamber,
activate said entry chamber conveyor to move said lens carrier into said entry chamber when said entry chamber is at ambient pressure and said first exit gate is closed,
thereafter, when said first entrance gate is closed, activate said first negative pressure source said first gas source to fill said area adjacent said first exit gate with said gas and to bring said entry chamber adjacent portion to said predetermined pressure,
thereafter open said first exit gate and said second entrance gate and activate said entry chamber conveyor and said coating chamber conveyor to move said lens carrier from said entry chamber into said coating chamber and between said electrodes,
activate said third negative pressure source and said third gas source to fill said exit chamber adjacent portion with said gas and to bring said exit chamber adjacent portion to said predetermined pressure,
thereafter open said second exit gate and said third entrance gate and activate said coating chamber conveyor and said exit chamber conveyor to move said lens carrier from said coating chamber to said exit chamber, and
thereafter close said third entrance gate.

18. The system as in claim 17, including a vent source in communication with said exit chamber to introduce a vent gas therein and wherein said control system is in operative communication with said vent source to introduce said vent gas into said exit chamber to bring a portion of said third exit chamber in which said carrier is disposed to ambient pressure after closing said third entrance gate.

19. A system for applying a polymer coating to optical lenses, said system comprising:

an entry lock chamber having a first gate at an entrance thereto;
an entry hold chamber having a second gate disposed between said entry lock and said entry hold, said first gate and said second gate sealing said entry lock chamber when closed;
a first conveyor disposed in said entry lock chamber and extending between said first gate and said second gate;
an entry buffer chamber having a third gate disposed between said entry hold chamber and said entry buffer chamber, said second gate and said third gate sealing said entry hold chamber when closed;
a second conveyor disposed in said entry hold chamber and extending between said second gate and said third gate;
a coating chamber in open communication with said entry buffer chamber;
an exit buffer chamber in open communication with said coating chamber;
an exit chamber having a fourth gate disposed between said exit buffer and said exit chamber and having a fifth gate at an exit of said exit chamber, said fourth gate and said fifth gate sealing said exit chamber when closed;
a third conveyor disposed in said entry buffer chamber, said coating chamber and said exit buffer chamber and extending between said third gate and said fourth gate;
a pair of spaced apart electrodes disposed in said coating chamber so that said third conveyor conveys a carrier of said lenses between said electrodes;
an electrical power source in communication with said electrodes to apply a predetermined electrical potential at each said electrode so that, upon establishment of a first predetermined pressure in said second chamber by said coating chamber negative pressure source, a plasma polymerization cloud of said gas is established between said electrodes;
a fourth conveyor disposed in said exit chamber and extending between said fourth gate and said fifth gate;
a respective negative pressure source in communication with each of said entry lock chamber, said entry hold chamber, said entry buffer chamber, said coating chamber, said exit buffer chamber and said exit chamber;
a respective source of plasma-polymerizable gas in selective communication with each of said entry hold chamber, said entry buffer chamber, said coating chamber, said exit buffer chamber and said exit chamber to introduce said polymerizable gas therein;
a first vent source in communication with said entry lock chamber to introduce a vent gas therein; and
a second vent source in communication with said exit hold chamber to introduce a vent gas therein,

wherein said entry lock chamber communicates with said entry hold chamber through said second gate so that said first conveyor and said second conveyor communicate to pass said lens carrier from said entry lock chamber to said entry hold chamber,
wherein said entry hold chamber communicates with said entry buffer chamber through said third gate so that said second conveyor and said third conveyor communicate to pass said lens carrier from said entry hold chamber to said entry buffer

said system includes a said respective negative pressure source in selective communication with each of said exit lock chamber and said exit hold chamber,
said system includes a said respective source of plasma polymerizable gas in communication with said exit hold chamber to introduce said gas into said exit hold chamber,
said second vent source is in communication with said exit lock chamber, and
said control system is configured to
after said lens carrier is moved from said exit buffer chamber to said exit hold chamber and said fourth gate is closed, activate said respective negative pressure source to remove said polymerizable gas from said exit hold chamber, activate said respective negative pressure source in communication with said exit lock chamber,
thereafter, when said lens carrier is in said exit hold chamber, said polymerizable gas has been removed from said exit hold chamber and said exit hold and exit lock chambers are at the same pressure, open said sixth gate and activate said fourth conveyor to move said lens carrier from said exit hold chamber to said exit lock chamber,
thereafter, close said sixth gate, and
thereafter, activate said second vent source to introduce said vent gas into said exit lock chamber and bring said exit lock chamber to ambient pressure.

25. A method for treating the surface of an optical lens, said method comprising the steps of:

(A) providing said optical lens;
(B) providing a coating chamber including a pair of spaced apart electrodes disposed therein;
(C) maintaining a plasma gas in said coating chamber;
(D) maintaining a first predetermined pressure in said coating chamber and a predetermined electric potential at each said electrode so that a plasma cloud of said gas is established between said electrodes;
(E) providing an entry chamber upstream from said coating chamber;
(F) moving said first lens into said entry chamber;
(G) introducing said gas into at least a portion of said entry chamber adjacent said coating chamber and bringing said at least a portion of said entry chamber to said first predetermined pressure;
(H) bringing said entry chamber into communication with said coating chamber;
(I) moving said first lens from said entry chamber into said coating chamber and through said cloud;
(J) providing an exit chamber downstream from said coating chamber;
(K) introducing said gas into at least a portion of said exit chamber adjacent said coating chamber and bringing said at least a portion of said exit chamber to said first predetermined pressure; and
(L) moving said first lens from said coating chamber to said exit chamber.

26. The method as in claim 25, wherein said gas is a plasma polymerizable gas.

27. The method as in claim 25, including, following moving said first lens into said coating chamber in step (I), sealing said entry chamber from said coating chamber, bringing at least a portion of said entry chamber to ambient pressure, bringing a second said lens into said entry chamber, and thereafter performing steps (G) through (L) with respect to said second lens.

28. The method as in claim 25, wherein

step (E) includes providing said entry chamber having an entry lock chamber and an entry hold chamber, said entry hold chamber being in communication with said coating chamber and said entry lock chamber being upstream from and in communication with said entry hold chamber,
step (F) includes moving said first lens into said entry lock chamber,
said method includes, following step (F), the steps

(M) bringing said entry lock chamber and said entry hold chamber to a second predetermined pressure,
(N) bringing said entry lock chamber into communication with said entry hold chamber and moving said lens from said entry lock chamber into said entry hold chamber, and(O) sealing said entry hold chamber from said entry lock chamber,

step (G) includes introducing said gas into said entry hold chamber and bringing said entry hold chamber to said first predetermined pressure,
step (H) includes bringing said entry hold chamber into communication with said coating chamber, and
step (I) includes moving said first lens from said entry hold chamber into said coating chamber and through said cloud.

and a first exit gate, said first entrance gate and said first exit gate sealing said entry chamber when closed, and said entry chamber including means for conveying said lens between said first entrance gate and said first exit gate;
means for selectively applying negative pressure to said entry chamber;
a coating chamber having a second entrance gate and a second exit gate, said second entrance gate and said second exit gate sealing said coating chamber when closed; means for introducing a plasma gas into said coating chamber;
means for applying negative pressure to said coating chamber;
means for maintaining a plasma cloud of said gas in said coating chamber;
means for conveying said lens through said cloud;
an exit chamber having a third entrance gate and a third exit gate, said third entrance gate and said third exit gate sealing said exit chamber when closed and said exit chamber including a means for conveying said lens between said third entrance gate and said third exit gate; and
means for selectively applying negative pressure to said exit chamber,

wherein said entry chamber communicates with said coating chamber through said first exit gate and said second entrance gate so that said entry chamber conveying means and said coating chamber conveying means communicate to pass said lens from said entry chamber to said coating chamber, and
wherein said coating chamber communicates with said exit chamber through said second exit gate and said third entrance gate so that said coating chamber conveying means and
said exit chamber conveying means communicate to pass said lens from said coating chamber to said exit chamber.

35. A continuous method for treating the surface of optical lenses, said method comprising the steps of:

(A) providing said optical lenses in batches,
(B) providing a coating chamber including a pair of spaced apart electrodes disposed therein, and
(C) maintaining a plasma gas in said coating chamber,

wherein said plasma gas is continuously maintained in said coating chamber between said batches, and said plasma gas produced from a process gas containing oxygen.

36. A system for treating the surface of an optical lens, said system comprising:

an entry chamber; a coating chamber downstream from said entry chamber and including a pair of spaced apart electrodes disposed therein;
an exit chamber downstream from said coating chamber;
a conveyor extending through said entry chamber, said coating chamber and said exit chamber so that said conveyor conveys said lens between said electrodes;
a source of plasma gas in communication with said coating chamber to introduce said gas into said coating chamber;
a negative pressure source in communication with said entry chamber, said coating chamber and said exit chamber;
an electrical power source in communication with said electrodes so that, upon introduction of said gas in said coating chamber by said gas source and upon establishment of a predetermined pressure in said coating chamber by said negative pressure source and of a predetermined potential at each said electrode, a plasma cloud of said gas is established between said electrodes; and
a control system in communication with said negative pressure source, said entry chamber, said coating chamber, said exit chamber and said conveyor, said control system configured to move said lens through each said chamber by said conveyor, to selectively seal said entry chamber from said coating chamber and said exit chamber from said coating chamber and to selectively pressurize and depressurize said entry chamber and said exit chamber.

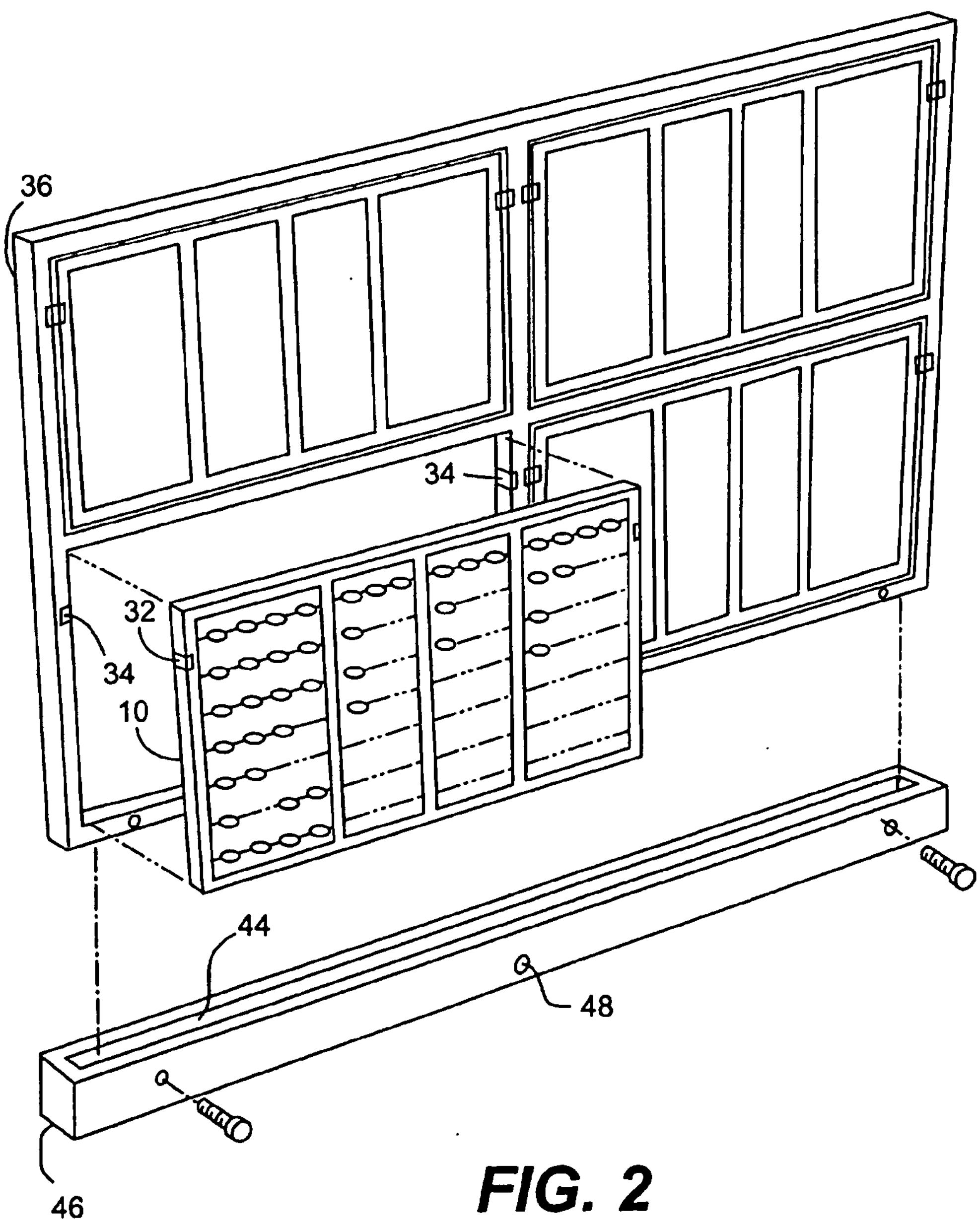
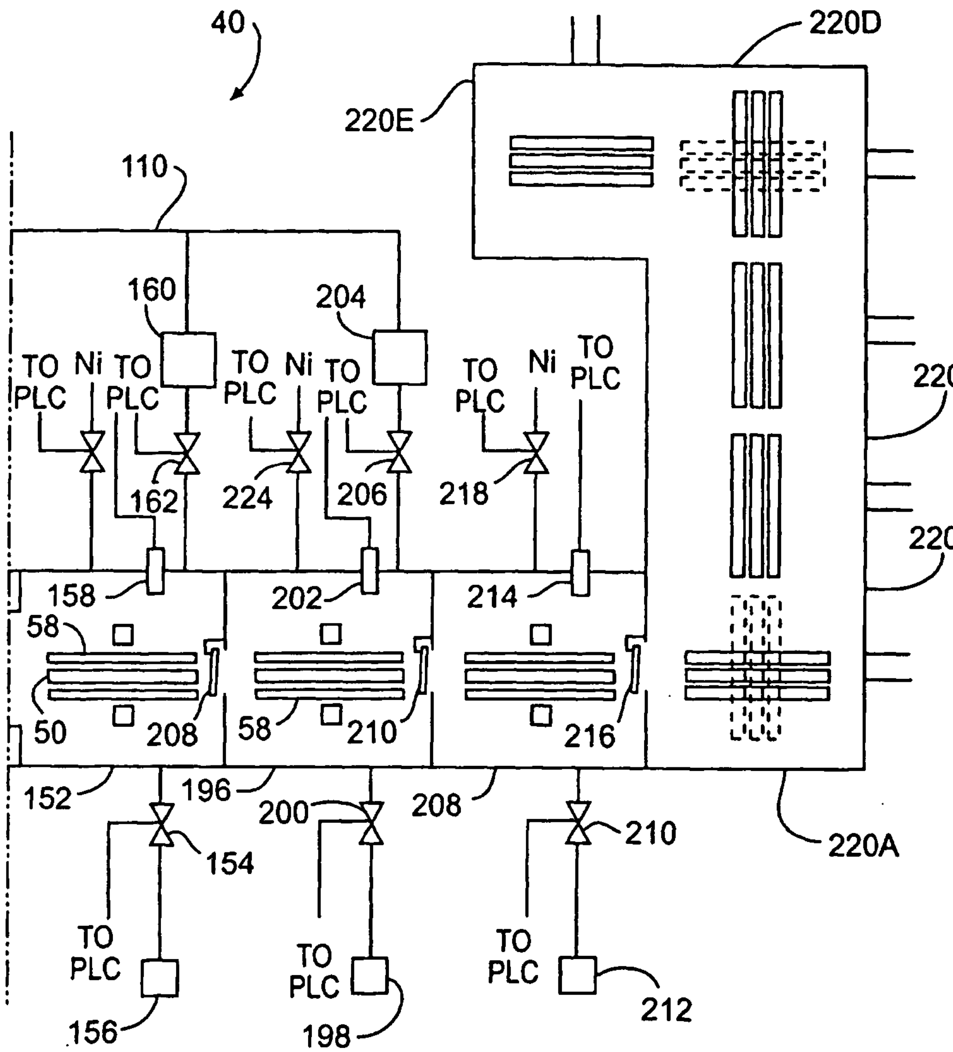


FIG. 2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204
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220E
220C
220B
220A
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TO PLC
TO PLC
TO PLC
156
198
212

FIG. 3B

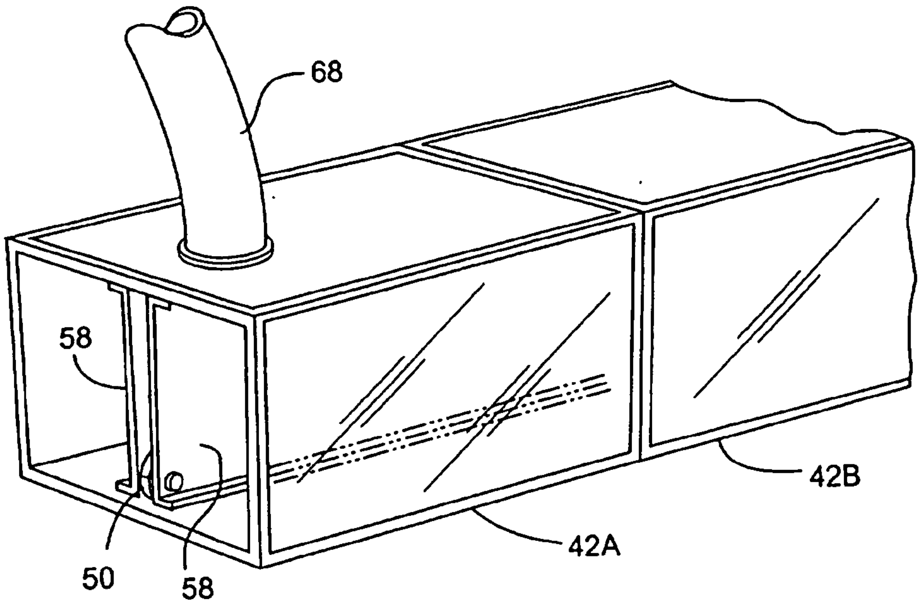

FIG. 4C

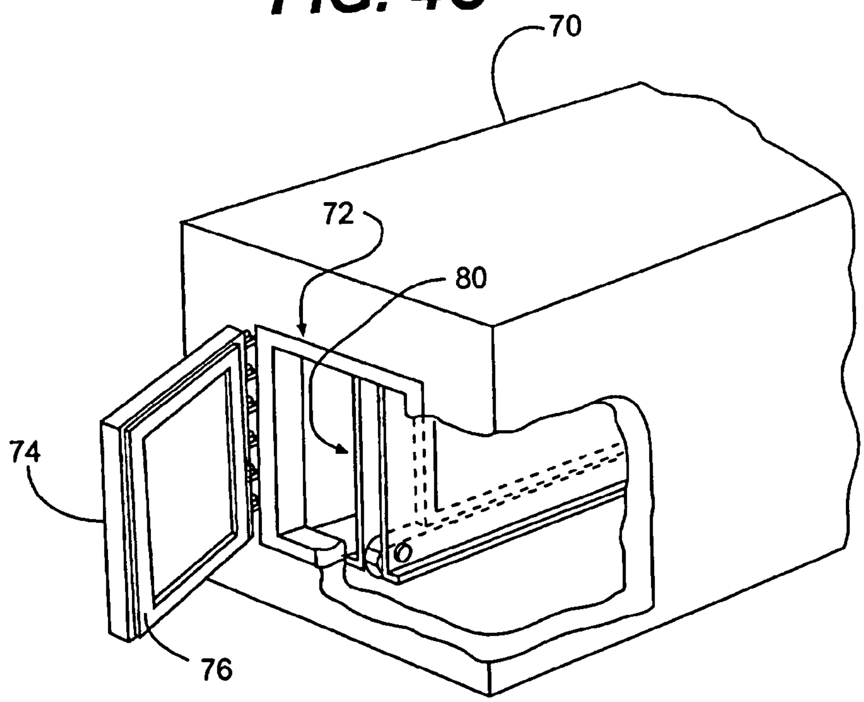

FIG. 5A

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(54) Lens plasma coating system

(57) A system and method for treating the surface of an optical lens is provided. A predetermined pressure and a plasma gas are maintained in a coating chamber. A plasma cloud of gas is established between electrodes in the chamber. An entry chamber is upstream from the coating chamber, and an exit chamber is disposed downstream from the chamber. A lens is moved into the entry chamber, and at least a portion of the entry chamber adjacent to the coating chamber is brought to the predetermined pressure. Process gas is introduced into this area. The entry chamber is then brought into communication with the coating chamber, and the lens is moved into the coating chamber and through the cloud. Process gas is introduced into at least a portion of the exit chamber adjacent the coating chamber, and this portion is brought to the predetermined pressure. The lens is then moved from the coating chamber to the exit chamber.

EP 1 180 429 A3

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 01 11 8881

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82